DISTRIBUTION AND CHARACTERIZATION OF THE MATURITY STAGES OF *OIKOPLEURA DIOICA* (TUNICATA, APPENDICULARIA) IN THE AREA OF PENINSULA VALDÉS, ARGENTINA

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ABSTRACT

The distribution of *Oikopleura dioica* Fol, 1872 was studied in the frontal area of Península Valdés, Argentina. The plankton sampling was conducted along four transects with five stations each, at five levels from 0 to 50m in depth. *Oikopleura dioica* densities depend on latitude (the southernmost transects showed the greatest densities) and distance to shore (at coastal stations *O. dioica* was more abundant). The vertical distribution of the species in the water column was affected by the thermocline and differed among transects. At well stratified stations, densities were greater below the thermocline. In mixed areas, the upper levels were more abundant. Morphometric analysis of developmental stages demonstrated that trunk length cannot be directly used to distinguish among developmental stages, since the species attains sexual maturity at different lengths. Although a high size variability was found within the mature stage (0.60-1.20mm), males and females differed in gonad height, being higher in males.

KEYWORDS. Appendicularia, distribution, maturity stages, South West Atlantic.

INTRODUCTION

Oikopleura dioica Fol, 1872 is a predominantly coastal species, being the sole representative of the Appendicularia with separate sexes. It is widely distributed along the Argentine coast from the La Plata River to Tierra del Fuego (ESNAL, 1973, 1978, 1981; BÜCKMANN, 1974), but up to now only data from isolated stations are available. This paper reports on a distributional study in an hydrologically very complex region: the frontal area off Peninsula Valdés, Argentina, characterized by a typical vertical temperature distribution with marked horizontal gradients. There, three zones can be distinguished: an inshore belt characterized by intense vertical mixing due to strong tidal currents running close to the peninsula and temperature gradients of less than 0.5°C in the upper 50m; a transition zone and an offshore region with marked stratification. The offshore gradient reaches values of more than 5°C in the upper 50m (CARRETO **et al.**, 1981; GLORIOSO,

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1987).

The developmental staging of *O. dioica* was approached through numerical methods in order to assess the relevance of several morphometric variables in their differentiation.

MATERIAL AND METHODS

Samples were collected by "R. V. Meteor" during cruise 11/3 conducted from December 6 to 12, 1989 (NELLEN, 1990). The study area extended from 42º to 44º S and to 62º to 65º W along the Argentina Patagonian coastline. The design comprised four transects (fig. 1) with 5 stations each, sampled from 0 to 50m depth. Transect 1 covered the three hydrological regions described above, while the remaining transects fell in the stratified region. Stations in transect 2 were characterized by higher temperature (about 20º C) and marked vertical gradients. The stratification observed at transects 3 and 4 showed less pronounced gradients. Samples were obtained using a modified MOCNESS-1 multinet (BIOMOC) with 0. 30mm mesh and 1 m^2 opening. Sensors attached to the net recorded water column temperature and salinity. Organisms were preserved in 2% formaldehyde and deposited in the Instituto Nacional de Investigación y Desarrollo Pesquero, Mar del Plata, Argentina. A total of one hundred and fifteen samples was obtained. Specimens were counted and staged recording densities at each station and depth level as number of specimens per cubic meter.

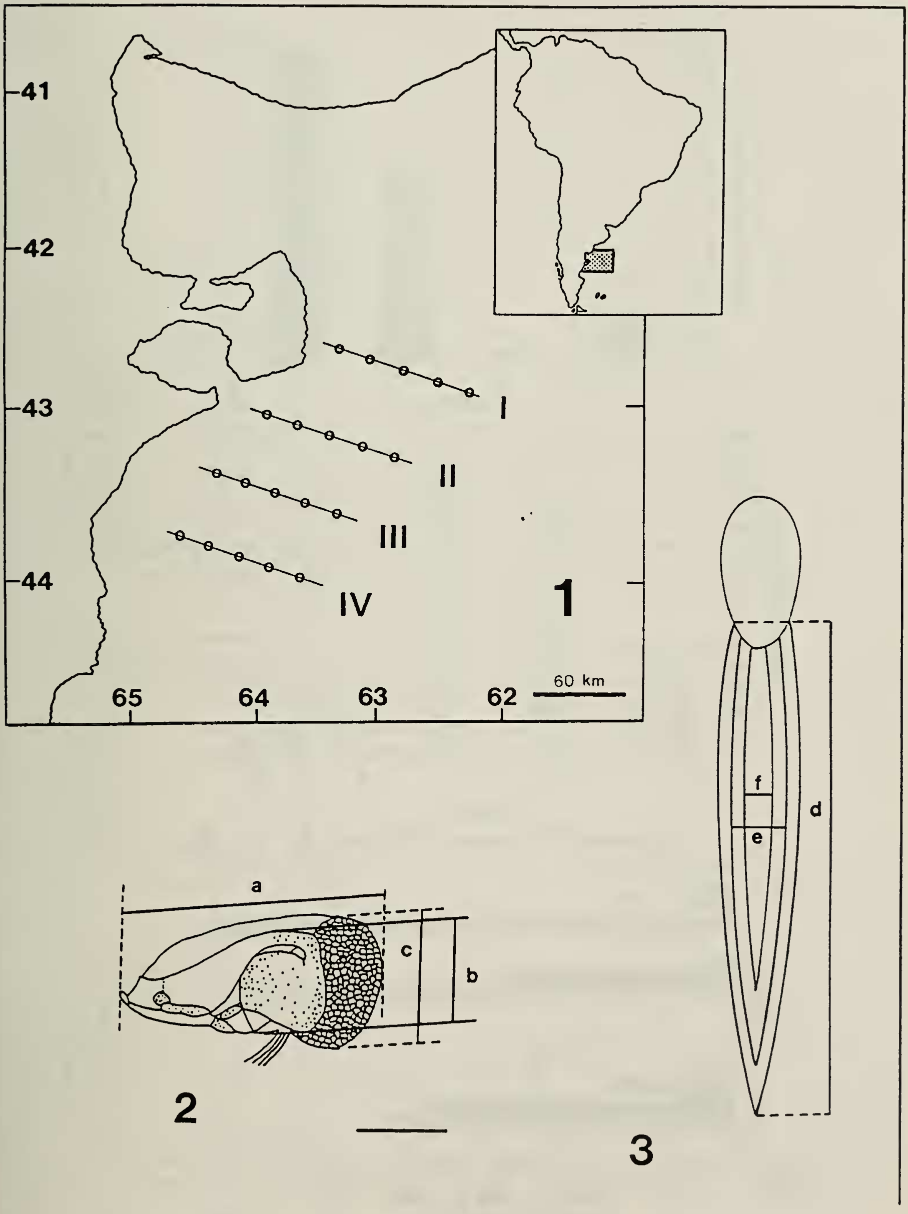
The *O. dioica* specimens were classified as mature female, mature male, "intermediate" or immature, taking into account its maturity stage based on FENAUX (1976), ESNAL & CASTRO (1977) and ESNAL **et al.** (1985) and are: (1) mature, when the gonad is turgescent and the gonad height exceeds trunk height at the stomach level; (2) intermediate specimens show a conspicuous gonad whose height is close to mean trunk height; (3) immature, when the gonad is scarcely developed, and the trunk height at the stomach level is higher than the gonad height. Sex differentiation could only be observed in mature organisms in which there is a difference in gonad texture between male and female. Both ovary and testis look granulous but the former shows big spherical cells whereas in the latter gonad texture looks like fine grains. Differentiation in termediate stages is not possible without a previous histological study. Morphometric measurements were taken in 198 females, 127 males, 58 intermediates and 58 immatures. Measured variables are: trunk length (LT), trunk height at the stomach level (HM), gonad height (HG), tail musculature length (LC) and width (MC) and notochord width (NC) (figs. 2,3).

The vertical distribution was studied using the profile analysis technique in order to detect possible vertical depth migration and or preferred depths or combinations of maturity stage and depth. As no significant results have been found with regard to the depth factor an overall 0-50m density was calculated for each station, pooling all stages together. This variable was analyzed in a two-factor ANOVA design were the factors transect and position relative to shore were tested (MORRISON, 1976). The discriminant analysis technique was applied to obtain a classification of specimens based on the morphometric variables described above. Discriminant functions were constructed in order to assess the relative constributions of the morphometric variables. Their adequacy in reconstructing the classification was evaluated as the percentage of agreement between the discriminant and the morphological methods.

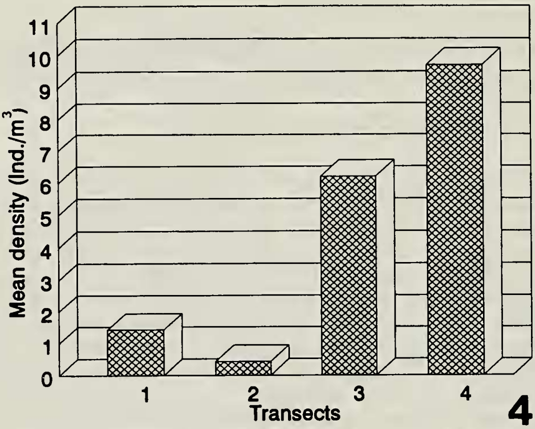
RESULTS AND DISCUSSION

Species density in the four transects (fig. 4), the statistical analysis (tab. I) and the abundance and distribution at the different stations in each transect (fig. 5) show that stations located in the southernmost transects exhibit greater densities while a definite pattern is not found in relation neither with depth nor position. Individual density as a function of depth at the first station of each transect (fig. 6) shows that at 0m, the depth stations located near to shore seem to have higher densities than those offshore; a result which is coincident with the known preference of this species for neritic waters.

The vertical distribution varies among transects. At transect 1 *O. dioica* is more abundant in the upper layer in the nearshore area, while in the remaining transects it is evenly distributed through all depth levels (figs. 7-14). Profile analysis has not yielded any significant results.



Figs. 1-3. 1, Geographic position of the transects with five stations each in the frontal area of Valdés Peninsula, Argentina; 2, trunk parameters measured of *Oikopleura dioica*: a) trunk length (LT), b) trunk height at the stomach level (HM), c) gonad height (HG); 3, measurement of the tail: d) tail musculature length (LC), e) width (MC), f) notochord width (NC). Scale: 0.25mm.



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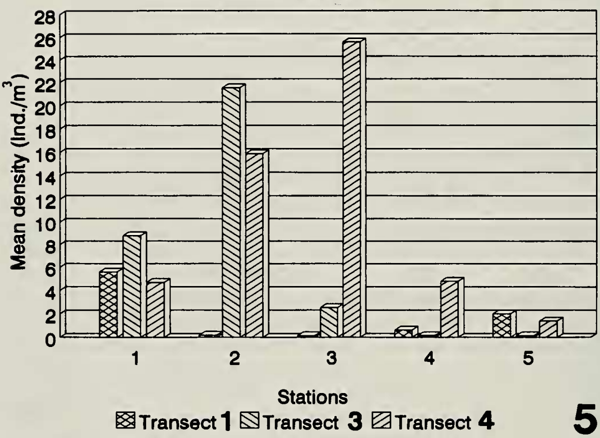

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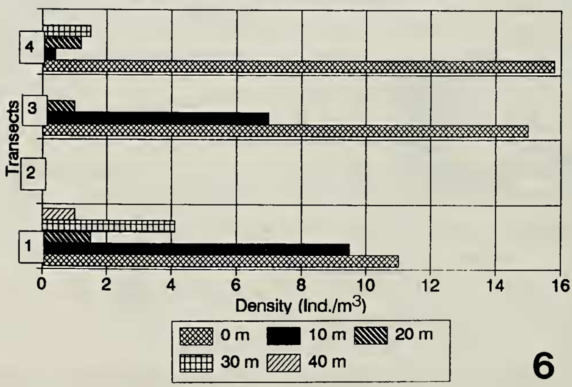

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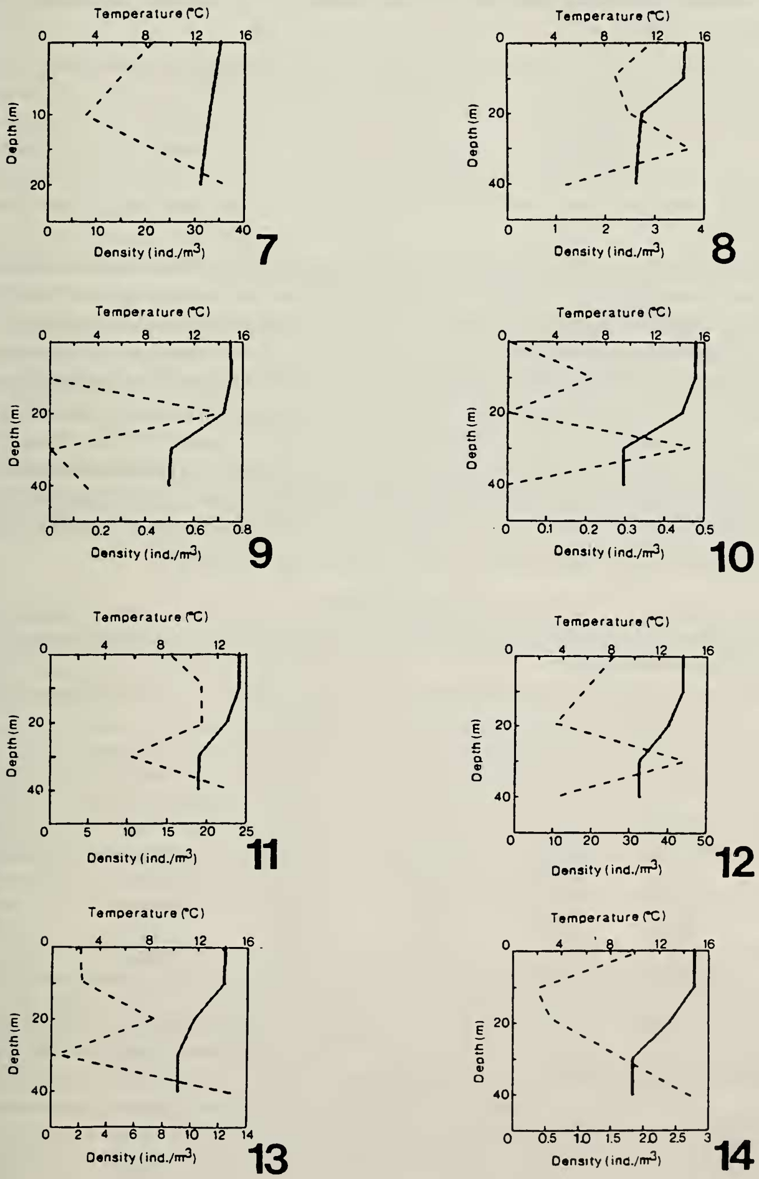
Figs. 4-6. *Oikopleura dioica:* 4, density at the four transects studied; 5, density at the different stations of transects 1, 3 and 4; 6, density as a function of depth at the first station of each transect.



Figs. 7-14. *Oikopleura dioica* distribution in relation with thermal stratification in transect 3: 7, station 2; 8, station 3; 9, station 4; 10, station 5; in transect 4: 11, station 2; 12, station 3; 13, station 4; 14, station 5. Solid line: temperature (ºC); dashed line: density (ind./m³).

Table I. *Oikopleura dioica* in the Península Valdés: anova table (transect x station). SS: square sum, DF: degrees of freedom, CM: mean square error. The value marked with an asterisk is significant at 0.05 level compared with an F= 5.19.

Source	SS	DF	CM	F
Transect	64.2815	3	21.4272	6.44*
Station	4.7539	4	1.1885	0.36
Error	39.9413	12	3.3284	–

Neither depth, nor the interactions depth-stage and depth-time seem to have any effect on the abundance of *O. dioica.* From the results of the two factor ANOVA (table I) it might be concluded that while the relative position to shore of the station is not significant, the transect itself is a significant factor governing the distribution of this species ($P < 0.05$). According to SHIGA (1993b) the distribution of *Oikopleura vanhoeffeni* Lohmann, 1896 is affected by the thermocline. This is also true for *O. dioica.* Thus, within the stratified zone (transects 3 and 4) individuals were more abundant in the deeper layers (30-40m) where the thermocline occurs. These water masses are characterized by low nutrient concentrations at the deeper levels, while nearshore areas are richer at the upper ones (CARRETO **et al.,** 1986). The strong thermal gradients found in transect 2 seem to affect this species and no individuals were found in these stations.

Table II. *Oikopleura dioica:* result of the discriminant analysis. Stage 1: females, 2: males, 3: intermediates, 4: immatures. Variables: trunk length (LT) and height (HM), gonad height (GH), tail musculature length (LC) and width (MC), notochord width (NC).

Stages	Variables					
	LT	HG	LC	MC	NC	HM
1 vs 2	0.1399	24.3782	1.1331	9.8492	23.0567	14.6294
1 vs 3	3.9736	29.3685	0.5116	1.4664	25.9201	14.7106
1 vs 4	8.0431	40.5976	0.8497	10.1700	10.1775	40.1358
2 vs 3	4.1135	53.7467	1.6447	10.3156	2.8634	29.3400
2 vs 4	7.9032	64.9758	1.9858	20.0192	12.8792	54.7652
3 vs 4	12.0167	11.2291	0.3381	8.7036	15.7426	25.4252

The discriminant analysis (table II) showed that the numerical classification of developmental stages is more related to gonad height and trunk height at the stomach level, than to the remaining variables. Although a high size variability was found in mature stages (0.60-1.20mm), males and females differed in gonad height, which is higher in the former (T test, $P < 0.0001$). Main variables used to differentiate maturity stages differ among species. For example, SHIGA (1993a) considers tail length a good criterion for maturity stages of *O. vanhoeffeni.* However, this is not the case for *O. dioica.* Discriminant analysis agreed with the morphological method for 84% of males (n=127), 66% of females (n=198), 76% of intermediates (n=58) and 80% of immatures (n=58). BÜCKMANN (1974) indicates that *O. dioica* attains sexual maturity at different trunk lengths. In consequence this variable would not be a good criterion for the differentiation of developmental stages. In the present dataset, trunk length and tail musculature length and width seem to be of little importance; gonad height, trunk height at the stomach level and, to a lesser extent, the notochord width being those variables most relevant to the discrimination among developmental stages. BRUNETTI **et al.** (1990) indicate a wide range of sizes for mature individuals in the lagoon of Venice (Italy) in spring. This is consistent with our observations, since trunk length measurements from our specimens in spring, ranged from 0.480 to 1.275mm. FENAUX (1976), using laboratory cultures, observed that individuals of the same culture developed asynchronically. Specimens of the same age attained different sizes and the release of gametes did not take place at a definite size. According to this author, the presence of ectoparasites produced a delay in growth but we did not find any parasitized specimens in our material.

A population study comparing stages would have been of interest. However, the use of a 0.30mm mesh net which underestimates smaller individuals, prevents this approach (FENAUX & PALAZZOLI, 1979). A more detailed statistical analysis of the distribution was not feasible, due to the small number of stations per transect and the lack of replications.

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